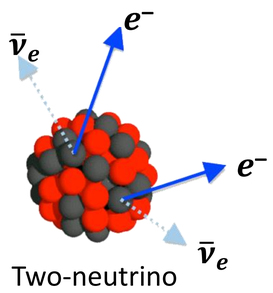
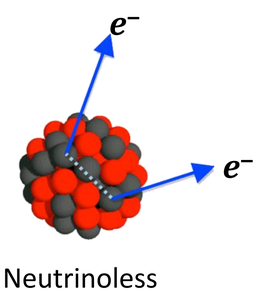
Particle track reconstruction for the SuperNEMO experiment

SuperNEMO detector

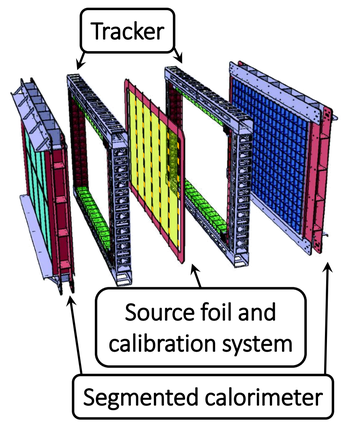
- **Powerful tool to study the physics of double beta ($\beta\beta$) decays**
- $\beta\beta$ standard observable – sum of the two electrons' energies
- **Unique design = calorimetry + tracking:**
  - Full event topology reconstruction (decay angle, single e^- energy)
  - Allows to study **exotic $\beta\beta$ modes** and its **mechanisms** – see poster **#851**



Two-neutrino $\beta\beta$ decay



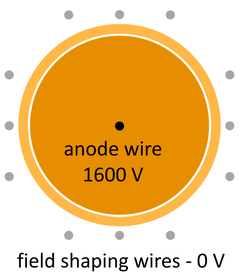
Neutrinoless $\beta\beta$ decay

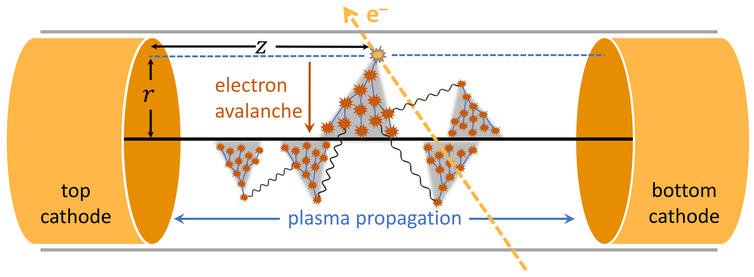


- **Main components:**
  - **Source foil:** 6.11 kg of ^{82}Se
  - **Tracker:** multiwire chamber (2034 drift cells) → **topology**
  - **Segmented calorimeter:** 712 optical modules → **energy**
  - **^{207}Bi calibration system:** 7 x 6 grid of point-like deployable sources

Tracker cell

- 44 x 44 x 3030 mm^3 drift cell in Geiger mode



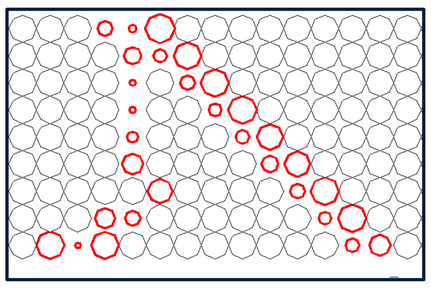


- Measures position of a passing charged particle:
  - Electron avalanche → Distance to anode wire (r)
  - Plasma propagation → Vertical position (z)

} **Tracker hit = circle tangent to the track**

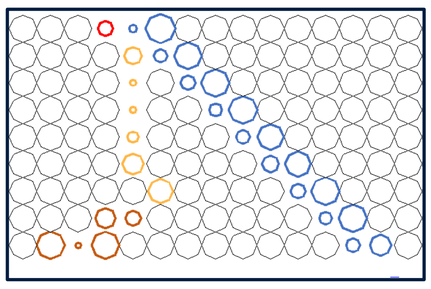
Track reconstruction

Input tracker data



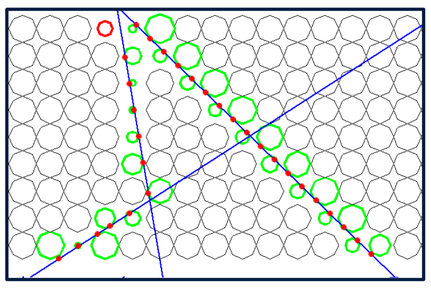
- View from the top of the detector
- No magnetic field → **straight line tracks**

Phase 1: Tracker hit clustering



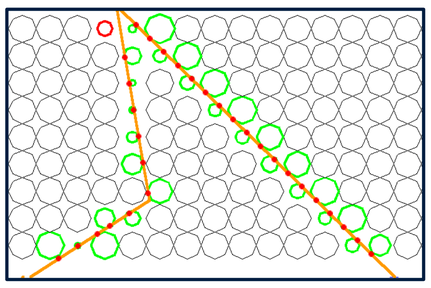
- Two complementary algorithms
  - **Legendre transform** clustering
  - **Hough transform** clustering

Phase 2: Linear segment reconstruction

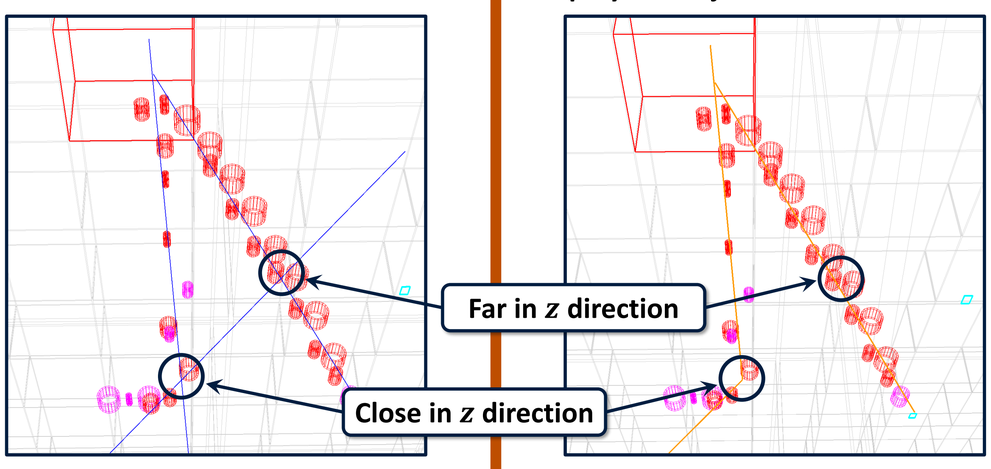


- Best fit in 3D using **Maximum likelihood method**

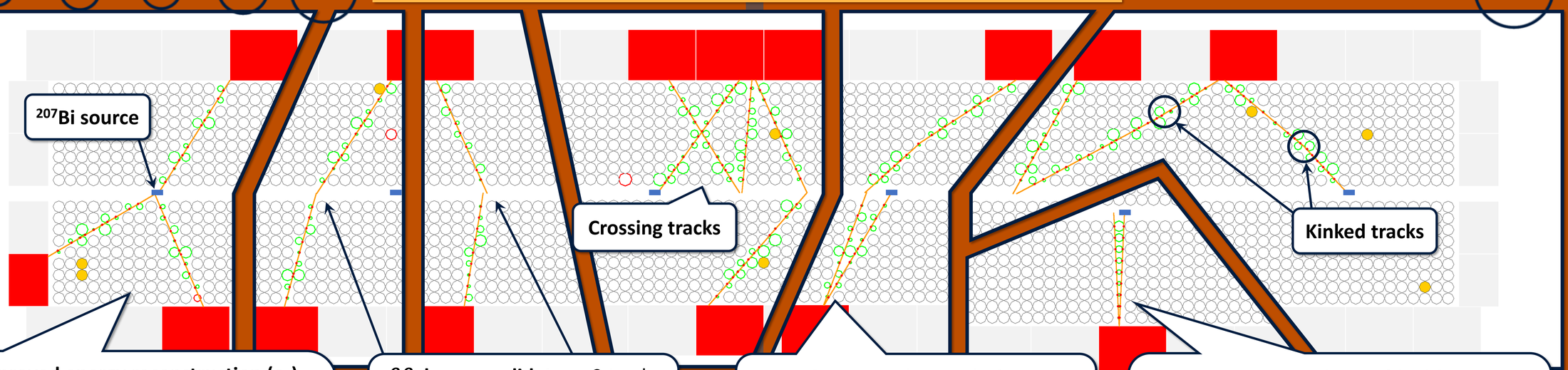
Phase 3: Trajectory constructor



- Linear segments connected into **polyline trajectories**



Performance on reconstructed real data



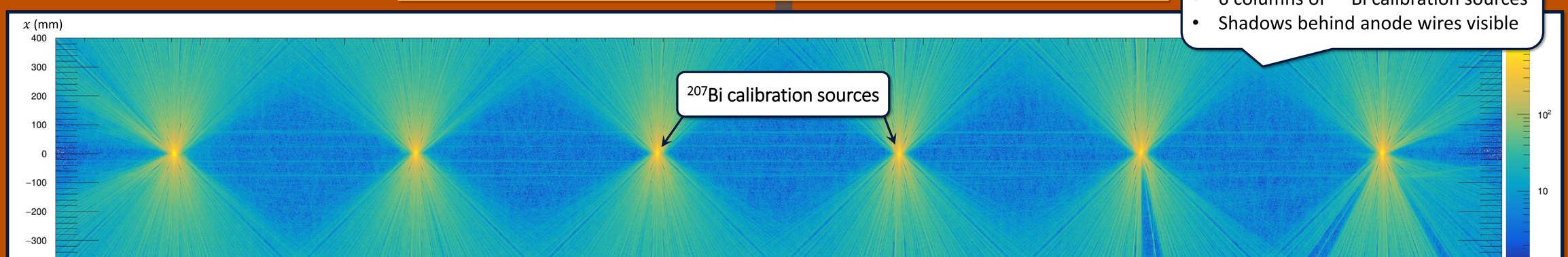
Improved energy reconstruction (e^-)
- Background rejection
- Track length → energy loss correction
- Reconstructed impact point on optical module → geometrical non-uniformity correction

$\beta\beta$ decay candidates = 2 tracks with close reconstructed vertexes on a source foil

Great angular resolution
- Close tracks with similar direction
- Important for studying decay angle

Reconstruction ambiguities
- Some events have 2 symmetrical solutions
- 4 possible axes of symmetry
- Always detected and reconstructed

Reconstructed tracks from calibration data



- ~10^5 reconstructed tracks overlaid
- 6 columns of ^{207}Bi calibration sources
- Shadows behind anode wires visible

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Tomáš Křižák on behalf of the SuperNEMO collaboration

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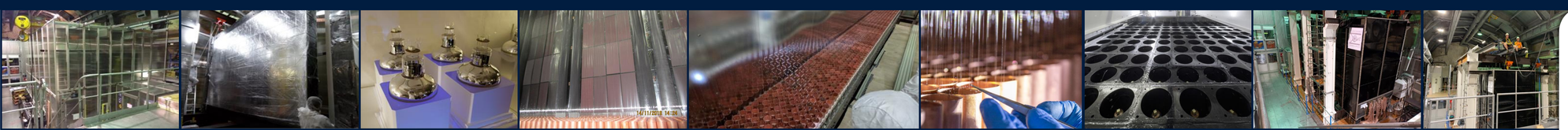

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